

CLAIMS

1. An ~~in-molded decorated~~ article comprising:
an ~~injection-molded~~ microcellular polymeric material having an average cell size of less
than 100 microns; and
a substrate adhered to a surface of the microcellular polymeric material.

2. The article of claim 1, wherein the substrate has a single layer.

3. The article of claim 1, wherein the substrate comprises a fabric material.

4. The article of claim 3, wherein the substrate comprises a single layer fabric material
having a thickness of less than 0.01 inches.

5. The article of claim 3, wherein the substrate comprises a polypropylene fabric.

6. The article of claim 1, wherein the substrate comprises a plastic film.

7. The article of claim 1, wherein the microcellular polymeric material is essentially free of
any residual chemical blowing agent or reaction by-product of chemical blowing agent.

8. ~~The article of claim 1, wherein the substrate is adhered to a surface of the microcellular~~
~~polymeric material in the absence of an external adhesive.~~

9. The article of claim 1, wherein the microcellular polymeric material has a softening
temperature and the substrate comprises a polymer having a softening temperature within 20 °C
of the softening temperature of the microcellular polymeric material.

10. The article of claim 9, wherein the substrate comprises a polymer having a softening
temperature within 10 °C of the softening temperature of the microcellular polymeric material.

5 12. The article of claim 1, wherein the polymeric material comprises polypropylene and the substrate comprises polypropylene.

13. The article of claim 1, wherein the polymeric material comprises acrylonitrile-butadiene-styrene and the substrate comprises polystyrene.

10 14. The article of claim 1, wherein the microcellular polymeric material has a void fraction of less than about 0.50.

15 15. The article of claim 14, wherein the microcellular polymeric material article has a void fraction of between about 0.05 and about 0.30.

16. The article of claim 1, wherein the article has a thickness of less than 0.1 inches.

17. The article of claim 1, wherein the article has a length-to-thickness ratio of at least about 50:1.

20 18. The article of claim 17, wherein the article has a length-to-thickness ratio of at least about 100:1.

25 19. The article of claim 18, wherein the article has a length-to-thickness ratio of at least about 200:1.

20. The article of claim 1, wherein the microcellular polymeric material has an average cell size of less than 50 microns.

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21. The article of claim 20, wherein the microcellular polymeric material has an average cell size of less than 25 microns.

22. The article of claim 1, wherein the substrate includes decorative features.

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23. The article of claim 1, wherein the substrate covers an entire first side of the microcellular polymeric material.

24. An in-mold decorated article comprising:

10 ~~an injection-molded polymeric foam material wherein at least 70% of the total number of cells have a cell size of less than 150 microns; and~~
~~a substrate adhered to a surface of the polymeric foam material.~~

15 ~~25. The article of claim 24, wherein the substrate includes a single layer.~~

26. The article of claim 24, wherein the substrate comprises a single layer fabric material having a thickness of less than 0.01 inches.

20 27. The article of claim 24, wherein the microcellular polymeric material is essentially free of any residual chemical blowing agent or reaction by-product of chemical blowing agent.

28. An in-mold decorated article comprising:

~~an injection-molded polymeric material; and~~
~~a single-layer fabric substrate adhered to a surface of the polymeric material.~~

29. The article of claim 28, wherein the polymeric material comprises a polymeric foam.

30. The article of claim 28, wherein the single-layer fabric substrate has a thickness of less than 0.01 inches.

31. An in-mold decorated article comprising:

an injection-molded polymeric material having a softening temperature; and
a substrate adhered to a surface of the injection molded polymeric material, the substrate
comprising a polymer having a softening temperature,
wherein the softening temperature of the injection molded polymeric material is within
20 °C of the softening temperature of the polymer of the substrate.

32. The article of claim 31, wherein the substrate comprises a polymer having a softening
temperature within 10 °C of the softening temperature of the microcellular polymeric material.

33. The article of claim 31, wherein the substrate comprises a polymer having a softening
temperature substantially equal to the softening temperature of the microcellular polymeric
material.

34. A method for forming an in-mold decorated article comprising:
molding a fluid polymeric material against a substrate; and
allowing the fluid polymeric material to harden and adhere to the substrate as a
microcellular polymeric material having an average cell size of less than 100 microns.

35. The method of claim 34, comprising molding a fluid polymeric material against a
substrate within a mold cavity.

36. The method of claim 35, further comprising injecting a mixture of polymeric material
and blowing agent into the mold cavity.

37. The method of claim 36, further comprising introducing a physical blowing agent into
the polymeric material to form the mixture of polymeric material and blowing agent.

38. The method of claim 37, comprising mixing the blowing agent and the polymeric
material under conditions at which the blowing agent is a supercritical fluid.

39. The method of claim 36, wherein the blowing agent comprises carbon dioxide.

40. The method of claim 36, wherein the blowing agent comprises nitrogen.

41. The method of claim 36, comprising injecting a single-phase solution of polymeric
5 material and blowing agent into the mold cavity.

42. The method of claim 34, wherein the substrate material has a single layer.

43. The method of claim 34, wherein the substrate comprises a fabric material.

44. The method of claim 43, wherein the substrate comprises a single layer fabric material
10 having a thickness of less than 0.01 inches.

45. The method of claim 34, wherein the substrate comprises a plastic film.

46. The method of claim 34, wherein the polymeric material comprises polypropylene and
15 the substrate comprises polypropylene.

47. The method of claim 34, wherein the polymeric material comprises acrylonitrile-
20 butadiene-styrene and the substrate comprises polystyrene.

48. The method of claim 34, wherein the microcellular polymeric material has an average
cell size of less than 50 microns.

25 49. A method for forming an in-mold decorated article comprising:
positioning a substrate material within a mold cavity;
introducing a physical blowing agent into polymeric material in a polymer processing
apparatus;
mixing the blowing agent and the polymeric material under conditions at which the
30 blowing agent is a supercritical fluid; and
injecting a mixture of polymeric material and blowing agent into the mold cavity.

50. The method of claim 49, further comprising forming an in-mold decorated article including a microcellular polymeric material with the substrate material adhered to a surface of the microcellular polymeric material, wherein the microcellular polymeric material has an average cell size of less than 100 microns.

51. The method of claim 49, further comprising forming an in-mold decorated article including a solid polymeric material with the substrate material adhered to a surface of the solid polymeric material.

52. The method of claim 49, wherein the blowing agent comprises carbon dioxide.

53. The method of claim 49, wherein the blowing agent comprises nitrogen.

54. The method of claim 49, comprising injecting a single-phase solution of polymeric material and blowing agent into the mold cavity.

55. The method of claim 49, wherein the substrate material has a single layer.

56. The method of claim 49, wherein the substrate comprises a fabric material.

57. The method of claim 56, wherein the substrate comprises a single layer fabric material having a thickness of less than 0.010 inches.

58. The method of claim 49, wherein the substrate comprises a plastic film.

59. A method for forming an in-mold decorated article comprising:
providing a polymer molding system including an extruder, a mold, and a substrate disposed within a cavity of the mold, the system constructed and arranged to deliver blowing-agent-free molten polymeric material from the extruder into the mold cavity at a minimum

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